

Experiences With RTEMS in Production at SPEAR

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Overview

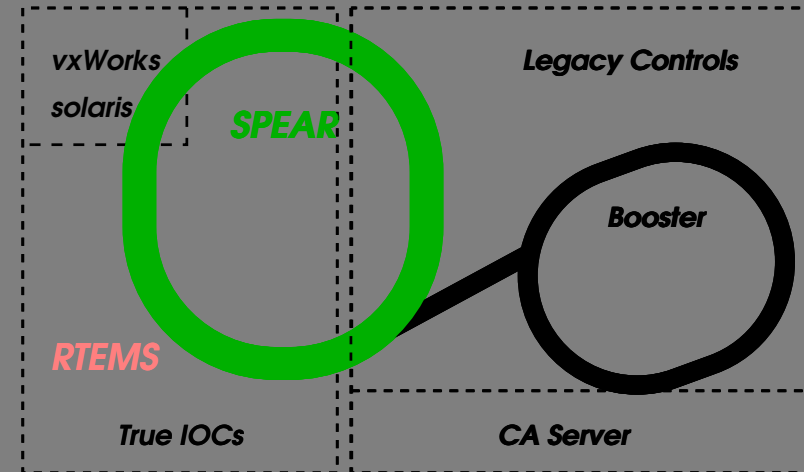
- Spear Control System Overview
- Spear EPICS IOCs
- Real-Time Orbit Control
- RTEMS Software Evolution
- Production Software Environment
- Q 'n A

The Spear Control System

3rd Generation light source
SW development 2000-2004
In situ replacement, summer 2003

Controls:

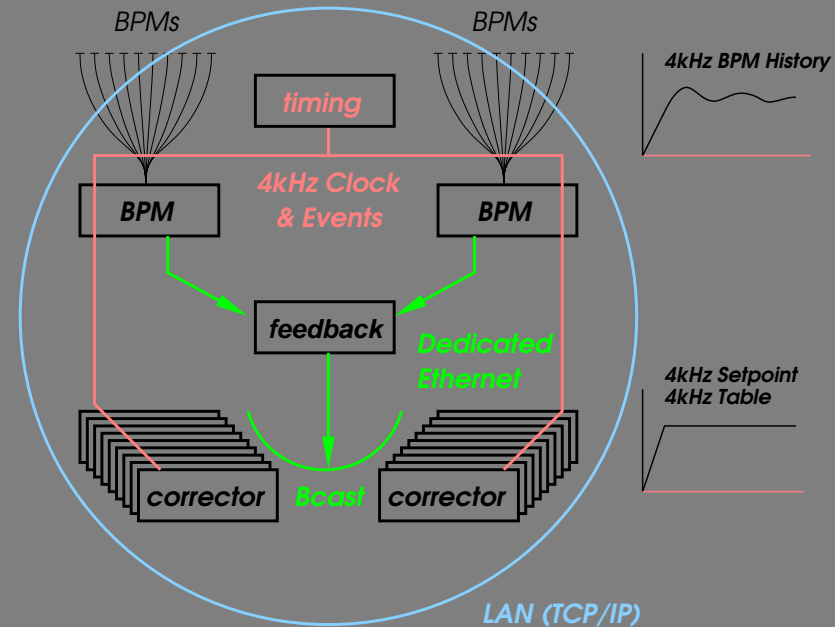
- Legacy control system (Camac, VMS) with CA server for booster and many Spear slow controls
- **25 EPICS IOCs running RTEMS**
- 1 EPICS/vxWorks IOC controls RF station (PEP2 technology, aka "black box")
- 1 "Soft" IOC on Solaris



Spear IOC Applications

Key Applications are fast orbit controls (eventually feedback):

- System clock rate: 4Khz
- Distributed:
 - 96 Beam position monitors (currently 57) are processed in two remote locations (2 IOCs)
 - 108 Fast corrector magnets are controlled by 18 IOCs
 - 4kHz clock & timestamps distribution
 - Synchronous capture of diagnostic waveforms; available over CA
 - 4kHz streamed data communication over dedicated ethernet
 - Central Orbit Feedback Processor (2004)

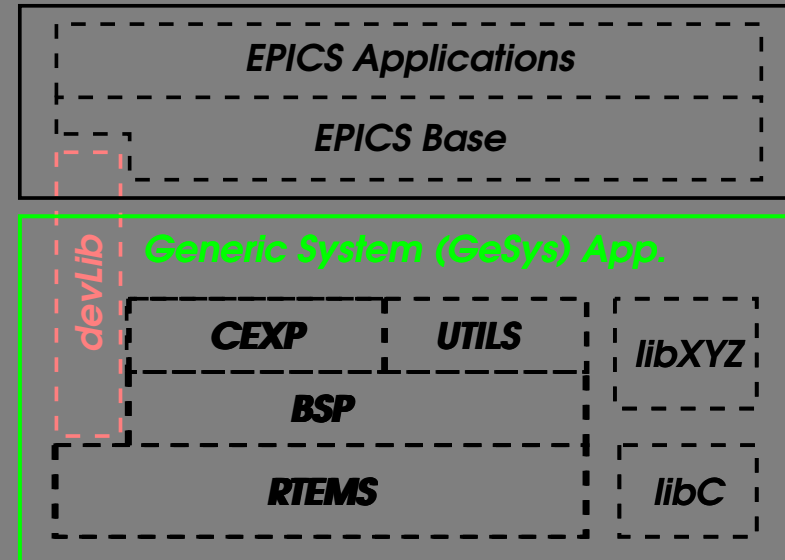


Real-Time Software Architecture

- Timestamp/Event receiver synchronizes high priority real-time task.
- (Trivial) non-OSI call needed for assigning priority. Everything else builds on libCom.
- I/O: Device support connects RT layer with EPICS db. RT-features integrate nicely with EPICS.
- Performance determined by underlying RTOS.

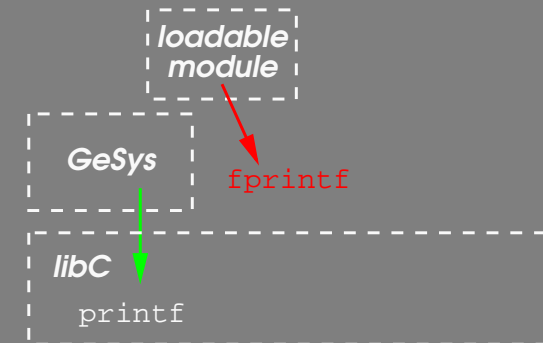
RTEMS Software Development Roadmap 2000-2004

- EPICS 3.14 / OSI; RTEMS port
- Performance Evaluation (ICALEPCS 2001)
- BSP (Synergy Microsystems VGM series SBC)
- Core software package (coll. meetings 2002)
 - Cexp shell (C expressions) and run-time loader/linker;
 - automatic symbol table access
 - trivial (nested) scripting
 - NFS client
 - Misc: (NTP client, telnet server, coredump, monitor)
 - Generic system application provides run-time environment a la vxWorks target shell (LDEP config utility)
- Available for PPC, PCx86, m68k (MVME167)
- devLib implementation makes porting ("3.14ification") existing drivers easy (IPAC, GTR)



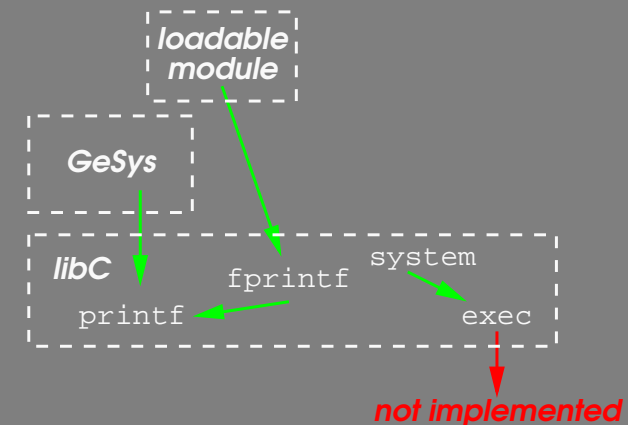
Library Dependency Issues with Run-Time Loading

- Generic system is statically linked and e.g., does not use "fprintf"
- Module referencing "fprintf" is loaded --> bumper



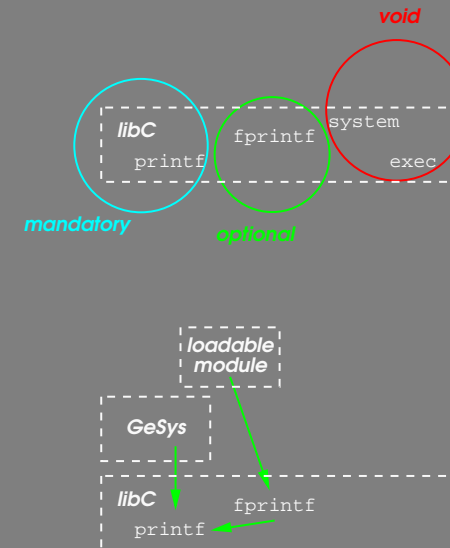
Library Dependency Issues with Run-Time Loading

- Just enforce linking whole library?
- Library might contain unused members with unresolved dependencies (e.g., unimplemented syscall)! Multiple dependency levels might be involved.



Library Dependency Issues with Run-Time Loading

- LDEP analyzes object interdependencies:
 - recursively remove dangling refs.
 - enforce linkage of configurable/optional library parts



Spear Production RTEMS Environment

Modular (eases maintenance, comfortable):

- Generic platform for all IOCs (GeSys)
- BOOTP/Netboot over TFTP (rsh, NFS) (minimize NVRAM settings)
- Generic add-on utilities (telnetd, ...)
- Multi-level scripts (generic system - IOC groups - IOC specific, ...) for loading EPICS applications & databases.
- Using C-expressions from scripts helps, e.g.:
`probeDriver("device") && dbLoadRecords("dbPiece.db","xxx")`

Main Applications

- RT for orbit control & feedback
- Slow bitbus power supply control
- IP modules (digital I/O, CANbus, Hytek ADC)
- PMC modules (64 channel 16bit parallel ADC, Ethernet, Race++)
- GPIB (various) over LAN
- VME boards (Echotek digital receiver, Joerger VTR, BitBus, Spear Timestamp)

Overall Experience

- In production on >20 IOCs
- Very reliable
- Good RT performance (4kHz tasks on 20 IOCs never missed schedule)
- Transparent to avg. EPICS developer
- Found 1 bug -- fixed within 1-2 days
- No licensing hassle, no fees
- Total control over fixing problems